Farmers' Bulletin 1092

United States Department of Agriculture

PRAIRIE RICE CULTURE

IN THE UNITED STATES

RICE produces its largest yields on clay soils that are not too deficient in organic matter. The land selected for rice culture should lie in level tracts that can be cheaply drained.

The crop requires an abundant and always available supply of fresh water, and to obtain good yields of high-grade rice ample drainage facilities must be provided.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches.

The field levees should be low, broad, and permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They also should be seeded to rice. This will increase the cultivated area and leave no uncultivated strips in the field for the growth of weeds.

The harvested rice should be put into strongly built shocks that should be well capped to protect the grain from the sun as well as from the rain. Thrashing should not be done until the rice has remained in the shock for at least two weeks.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. February, 1920

PRAIRIE RICE CULTURE IN THE UNITED STATES.

CHARLES E. CHAMBLISS,

Agronomist in Charge of Rice Investigations, Office of Cereal Investigations.

CONTENTS.

THE RICE PRAIRIES.

THE PRINCIPAL RICE REGION of the United States lies on the Gulf coastal plain, where there are broad, level prairies extending approximately from Rayne, La., to Crosby, Tex. (Fig. 1.)

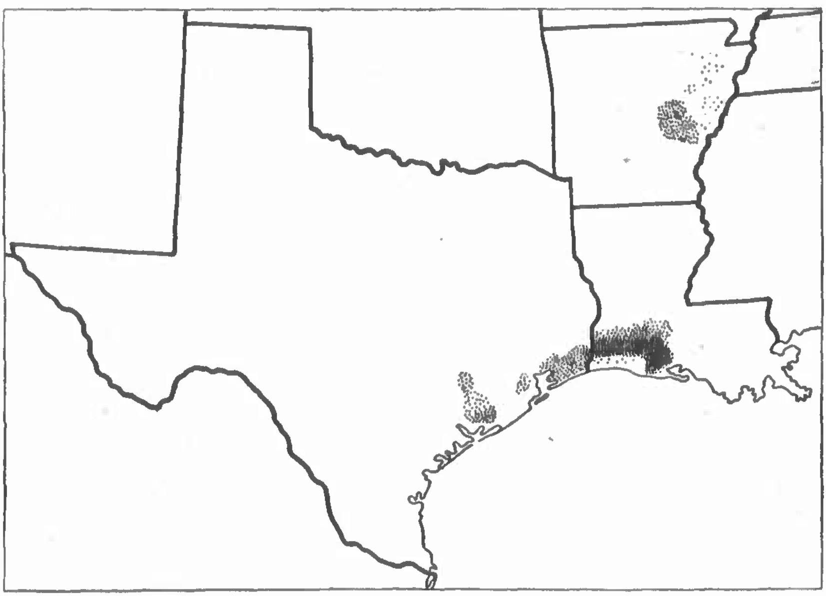

FIG. 1.—Outline map of Louisiana, Texas, and Arkansas, showing where prairie rice was grown in 1918 and indicating by dots the acreage devoted to the crop. Each dot represents 1,000 acres.

These tracts of level land are broken here and there by sluggish streams. From them the irrigation water is obtained by the use of powerful pumps. As these streams are much lower than the prairies,

they also serve as the natural outlets for drainage. Deep wells also are used in this section to supply irrigation water for approximately 150,000 acres.

The rice area in Louisiana is located on the prairies in the southwestern part of the State, with the exception of a narrow strip of alluvial land, totaling 89,000 acres, along the Mississippi River. Since the early part of the nineteenth century rice has been produced in Louisiana, but the crop remained unimportant until it was demonstrated in Acadia Parish that it could be grown on the prairies.

The effect of the successful outcome of this agricultural venture increased the rice area in the State from 42,000 acres in 1879 to 84,377 acres in 1889. During the next 10 years there was such an increase in the number of irrigation plants and at the same time so great an enlargement of the canal systems that the acreage in rice in Louisiana reached 201,685 acres. By 1918 the prairie rice area in that State had increased to 491,893 acres. In Texas, where rice is grown only under prairie conditions, the area devoted to the crop increased from 178 acres in 1889 to 245,000 acres in 1918, 136,520 acres of which were located in southeastern Texas.

In acreage and production of rice the Louisiana prairies rank first and those of Texas second. Of the 1,112,770 acres of rice grown in the United States in 1918, the Louisiana and Texas prairies contained 736,893 acres.

There is a similar, though smaller, prairie district in eastern Arkansas (fig. 1), approximately 50 miles wide and 150 miles long, which in 1918 produced 7,310,000 bushels on 170,000 acres. The rice industry is of recent development there, for it was in 1905 that Arkansas, with 460 acres of rice, was first included among the rice-producing States.

CLIMATE.

On the Gulf coastal plain the summers are hot, with a relatively high humidity. The hottest months are June, July, and August. The monthly mean temperature for these months ranges from 79.9° to 82.8° F. The annual mean temperature ranges from 67.4° to 69.1° F. There are seldom any killing frosts between March 4 and November 15. During the winter months the weather is usually mild, though freezing temperatures sometimes occur. The precipitation is well distributed throughout the year and is approximately all in the form of rain, which greatly increases from the western to the eastern portions of this region. In southeastern Texas the average annual rainfall is 47.6 inches, but in the eastern part of the prairie district of southwestern Louisiana it is 54.6 inches. Destructive winds are not frequent, but the Gulf coast is exposed to West Indian hurricanes.

The Arkansas rice belt has an annual mean temperature of 61.5° F., with hot summer months. Killing frosts usually are three weeks later in spring and two weeks earlier in autumn than on the Gulf coast. The average annual rainfall of 52.05 inches is rather evenly distributed.

SOILS.

Rice is more productive on soils of medium to rather heavy texture than on lighter loams and sandy soils. The typical rice soil of Arkansas and southwestern Louisiana is the Crowley silt loam. This soil is a brown or ash-gray loam containing approximately 4 per cent of very fine sand, 69 per cent of silt, and 23 per cent of clay. It is noticeably rather compact in structure and has a tendency to puddle if plowed when wet. The subsoil, which lies at an average depth of 16 inches, is a mottled blue and yellow clay that is extremely impervious. The loss of irrigation water by seepage through this clay is so small that it is negligible.

In these districts there are other soils much lighter in texture on which rice is successfully grown. Beneath them the underlying soil is near the surface and is impervious; otherwise the soil would not be profitable for rice on account of the expense of maintaining the proper depth of irrigation water.

In Texas the soils are of a more tenacious character and therefore are more difficult to cultivate. They lie upon an impervious clay and on an average are no greater in depth than the Crowley silt loam. The Lake Charles clay is a typical rice soil of southeastern Texas. Its surface soil is dark gray, often mottled with yellowish brown, and 12 to 16 inches deep. The subsoil is similar in color and texture to a depth of 3 feet or more. There is considerable organic matter in the surface soil and subsoil, and yet this type of soil is very plastic and sticky when wet. This is characteristic of most of the rice soils of this State. Some of them crumble on drying, even when plowed in a very wet condition, while others can not be successfully cultivated unless plowed when the moisture conditions are just right. The latter is particularly true of the soils known as "hog-wallow land."

GENERAL REQUIREMENTS OF THE CROP.

Irrigation is an important feature in the culture of rice. Water must be applied continuously and at a uniform depth for many days. To meet these requirements the land which is selected for this crop should be level and underlain by a subsoil that is impervious to water. The expense of preparing a level tract for irrigation is less than for a rolling one, and the cost of maintenance is also less because there are fewer levees. The impervious stratum of soil

should lie near the surface, for a deep soil requires more water and more time for its submergence than a shallow one.

The importance of good drainage can not be too strongly emphasized. Without it, the field can not be quickly drained for harvest. A delay in draining a field may cause a heavy loss in yield. It is also necessary in order to prevent water-logging, a condition which unquestionably affects the yield.

Clay soils when easily drained and not too deficient in organic matter seem well suited to the production of rice. Loamy and even sandy soils produce good crops of rice under ideal conditions of irrigation and drainage.

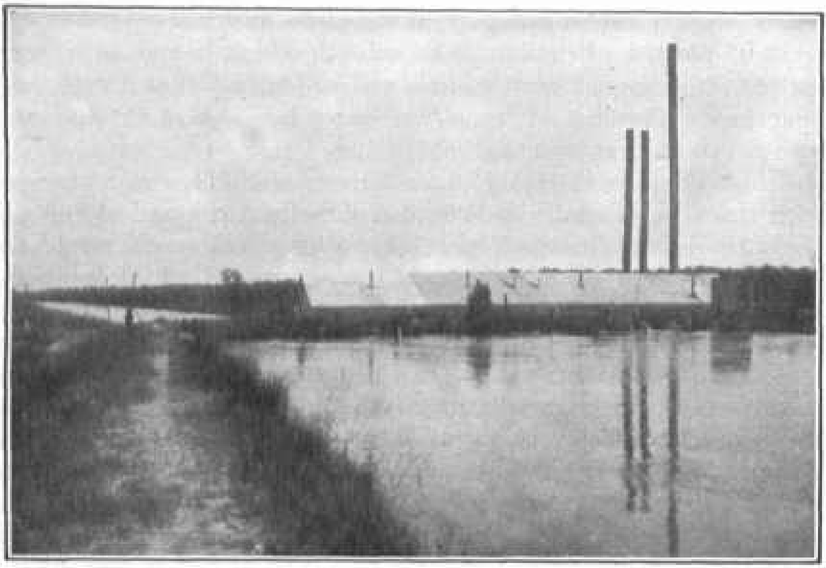

FIG. 2.—An irrigation canal and pumping plant, the second lift on the Neches Canal, Beaumont, Tex.

SOURCES OF IRRIGATION WATER.

The water needed for rice production on the prairies is obtained mostly from streams and wells. From the streams it is lifted by powerful pumps and distributed by canals, which are operated by private companies. These companies furnish the water on a rental basis. Before the recent war the rental ranged from $6 to $9 per acre per season. The water may be supplied in return for one-fifth of the crop, or it may be furnished for two bags of rice, averaging 180 pounds each, per acre. If land, seed, and water are furnished, a charge of one-half of the crop is made.

Although the major part of the rice acreage in Louisiana and Texas is irrigated from canals (fig. 2), the supply of water for at least 150,000 acres is obtained from deep wells. Most of the

water that is used in irrigating rice in Arkansas is supplied from deep wells. When the deep well is the source of the water supply, the well and outfit are included in the farm equipment. The size and capacity of the pumping outfit depend upon the acreage to be irrigated and the height to which the water must be lifted. The minimum capacity of the pump should not be less than 7½ gallons, or 1 cubic foot of water per minute per acre.[1] Some of the less compact soils which are used for rice require at least 10 gallons per minute per acre.

METHOD OF APPLYING IRRIGATION WATER.

Level land with a gentle slope is well suited to the irrigation of rice. With such surface features a field can be irrigated economically and drained satisfactorily if the natural outlets are not too small or overtaxed. A rice field must be inclosed by strong levees in order to hold the water that may be put upon it. As it is also important to maintain a rather uniform depth of water in irrigating rice, the field must be divided into as many subfields, or "cuts," as are necessary to obtain this condition.

A competent civil engineer should be employed to locate the levees, especially those that separate the subfields. These levees (see fig. 10) should be permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They should be at least 10 feet wide at the base and built up with sloping sides to a height that is just sufficient to prevent the water from overflowing into the subfields below. All kinds of farm machinery may easily pass over levees of this character without damaging them. This simplifies field operations, for such levees make possible the cultivation of an entire field as a unit instead of the separate cultivation of "cuts," which is necessary where high narrow levees are used. They also are of further service, as they can be seeded to rice and thereby increase the cultivated area. This prevents any waste of land and leaves no uncultivated strips in the field for the growth of weeds. Rice that is produced on these levees often is of a very good quality. The yield from these plants, however, may be lower than from those more favorably located, but the results obtained in the control of weeds alone will justify the practice.

Firm and compact levees are necessary to reduce seepage. They should be constructed and rebuilt during the winter. When constructed at this time they are more serviceable than when made just before water is applied. It is better to build new levees at least one-third higher than the required height. This will allow for settling

[1] Haskell, C. G. Irrigation practice in rice growing. U. S. Dept. Agr., Farmers' Bul. 673, 12 p., 1 fig. 1915.

and washing. It is cheaper than building up the levees with the shovel after the land has been submerged. The average cost of constructing field levees and laterals before the war was approximately $1.50 per acre. On land where only a few levees were needed the cost was as low as 20 cents per acre.

The water is admitted to subfields through openings in the levees. These openings should be controlled by wooden gates and not made with a shovel each time water is needed. The gates should consist of a floor and end pieces to hold a sliding shutter in a vertical position across the opening. The flow of water may be regulated by the shutter, which consists of narrow pieces of wood that may be increased in number or removed as the water is raised or lowered.

VARIETIES.

LONG-GRAIN RICE.

The long-grain rice of the United States is represented on a large commercial scale by the Honduras variety. Its seed is long and narrow, averaging in length two and one-half seeds and in width eight seeds to an inch. (Fig. 3.) It has a light-yellow awnless hull that

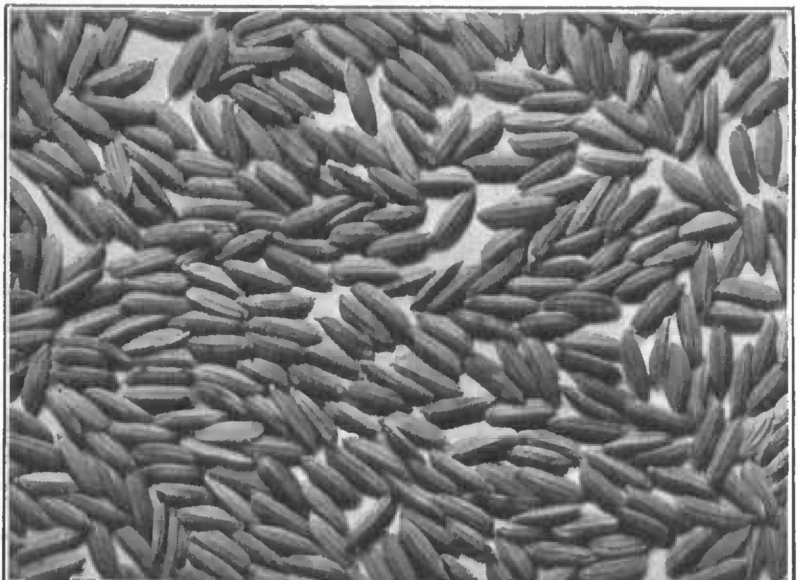

FIG. 3.—Seed rice of the Honduras variety. (Natural size.)

is thinly covered with short white hairs. The awn, however, often is present when the variety is grown on very rich soil.

This variety is grown in all prairie sections, producing its largest yields on land that has not been cropped too heavily to rice, but in yield and quality it reaches its maximum on the alluvial river-bottom lands of the Mississippi in Louisiana. It has an erect growth, aver-

aging 50 inches in height. Its stalks, which seldom exceed four per plant, are large and stiff and bear broad leaves. It shows no tendency to lodge except on very rich soil and withstands the usual winds and the rain accompanying the ordinary rainstorms. It is an early-maturing rice, requiring a growing season of approximately 128 days. In production it averages 1,996 pounds of paddy, or rough rice, per acre.

Honduras rice must be sown early enough to mature before becoming affected by the cooler nights and winds of September if maximum yields are to be obtained. For this reason this variety should be seeded not later than May 1. The entire plant matures rapidly, and any delay in harvesting may result in a low yield, because the branches of the head (botanically called a panicle) break off and drop shortly after maturity. The loss from this cause is greater than from the shattering of the grain. This variety is very susceptible to the fungous disease caused by Piricularia, and a delayed harvest increases the losses from this disease. To separate the grain from the straw requires careful thrashing. The stem and leaves are very brittle, and unless the thrasher is fed slowly it is not possible to get a good grade of rough rice.

SHORT-GRAIN RICE.

The short-grain varieties that are grown in this country are Japanese in origin and seem well adapted to prairie conditions. They are very hardy and produce large yields, but require a long growing season. On account of the first two qualities they are very popular with the farmers. They break less in milling than the long-grain varieties, and for this reason the millers prefer them. The general trade, however, shows a preference for the long-grain rice.

The Wataribune is a good example of the short-grain varieties. Its seed is short and broad, averaging in length four seeds and in width seven seeds to an inch. (Fig. 4.) The hull is light yellow in color and bears a light-yellow awn, at the base of which are tufts of short white hairs. Many of the awns drop before the crop is harvested, and those that remain are usually broken off in thrashing and in handling the sacks, so that this variety often goes to the mill with very few, if any, awns attached.

The Wataribune variety does not grow erect, but has a spreading habit and averages 39 inches in height. Its stalks, which seldom exceed nine per plant, are small and flexible and bear narrow leaves. On account of its spreading habit of growth and heavy heads, this variety has a tendency to lodge, which is very pronounced when grown on rich soil. On rather poor soil it may produce very good yields. It requires a long season, averaging 137 days, and produces on an average 2,600 pounds per acre. It should be harvested

when the heads are yellow and well turned down, though the stem and leaves may still be quite green.

The irrigation water may be removed at least five days earlier from a field containing Wataribune than from one containing Honduras rice, because the stems of this variety do not mature rapidly, nor does the grain shatter readily.

The thrashing of this variety requires close attention, but the difficulties may be lessened by feeding the machine slowly. Short-grain rices hull more readily in thrashing than the long-grain varieties, but an adjustment of the concaves will reduce this loss.

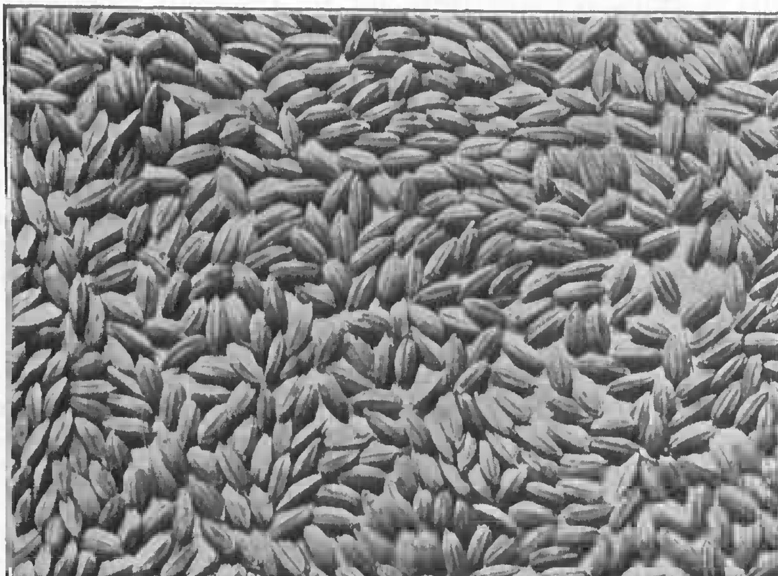

FIG. 4.—Seed rice of the Wataribune variety. (Natural size.)

MEDIUM-GRAIN RICE.

There is another variety of rice, known as Blue Rose, which is grown on a large acreage. Its grain is not as long as that of Honduras nor as short as that of Wataribune. The seed of this variety averages in length three and one-half seeds and in width seven and one-fifth seeds to an inch (fig. 5). Its light-yellow hull is thinly covered with short white hairs. These are numerous and conspicuous at the apex.

The Blue Rose variety has an erect growth and averages 44 inches in height. Its stalks are large and stiff, often numbering 13 per plant and bearing leaves which are broad, but not as wide as those of Honduras rice. On rich soil it shows a tendency to lodge, but in its resistance to wind it is very similar to the Honduras variety. It matures within 142 days and produces on an average about 2,500

pounds per acre. It should never be grown on very rich soil, and, unlike Wataribune, it makes very low yields on poor soil. The stem and leaves of this variety are still green when the grain is ripe enough to be harvested.

This rice should be handled at harvest in the same manner as the Wataribune variety. Any delay at this time may lessen production on account of its susceptibility to the fungous disease Piricularia. In thrashing there is some difficulty in preventing the large tough straw from clogging the cylinder and the leaves, which break easily, from going out with the grain.

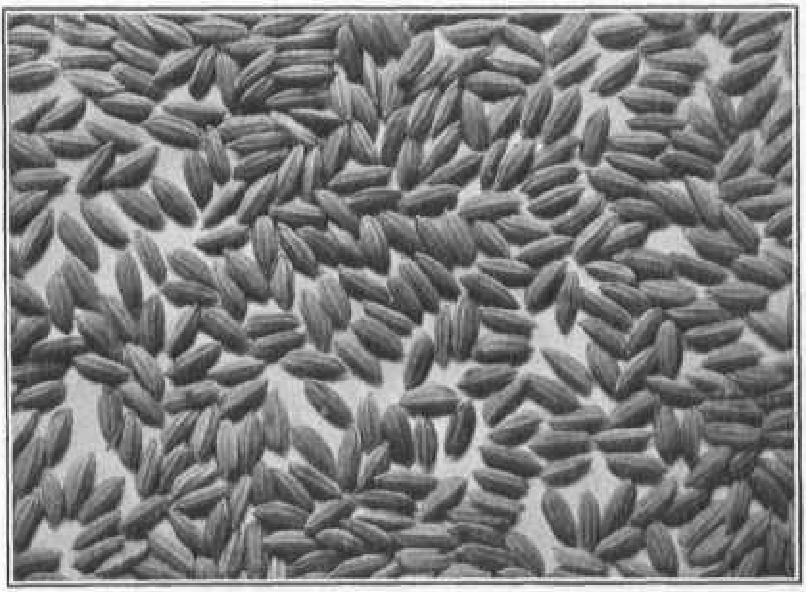

FIG. 5.—Seed rice of the Blue Rose variety. (Natural size.)

PREPARATION OF THE SEED BED.

In preparing a seed bed for rice the land should be plowed (fig. 6) in late autumn or winter to a depth of 5 to 7 inches.

It is not advisable, however, to break new land to this depth, especially if the soil is thin. Winter plowing will permit the free circulation of air in the soil if the land is well drained at this time. Under these conditions the frost will act upon the soil in such a way as to crumble it, and the winter rains will wash out any alkali that may have accumulated in the surface soil, producing a physical condition which permits easy preparation of the seed bed in the spring by disking and harrowing. It is, however, difficult and expensive to prepare land for seeding when it has been plowed in winter unless good drainage has been provided, for the lack of drainage during the winter may make it necessary to plow again in spring, thus adding to the cost of production.

On well-drained land the stubble and perennial weeds that are turned under by winter plowing decompose rapidly. This reduces the field operations in preparing the seed bed, which as a rule requires only one double disking and one harrowing (fig. 7) before seeding. A float (fig. 8) may be used to advantage to break the clods and level the field before disking. Before harrowing, the float may be used again to advantage. The number of times the float should be used will depend upon the condition and character of the soil. Land cropped to rice the previous year must have two double diskings after winter plowing. The first disking should be made in February or March, especially if there has been very little rain during the winter.

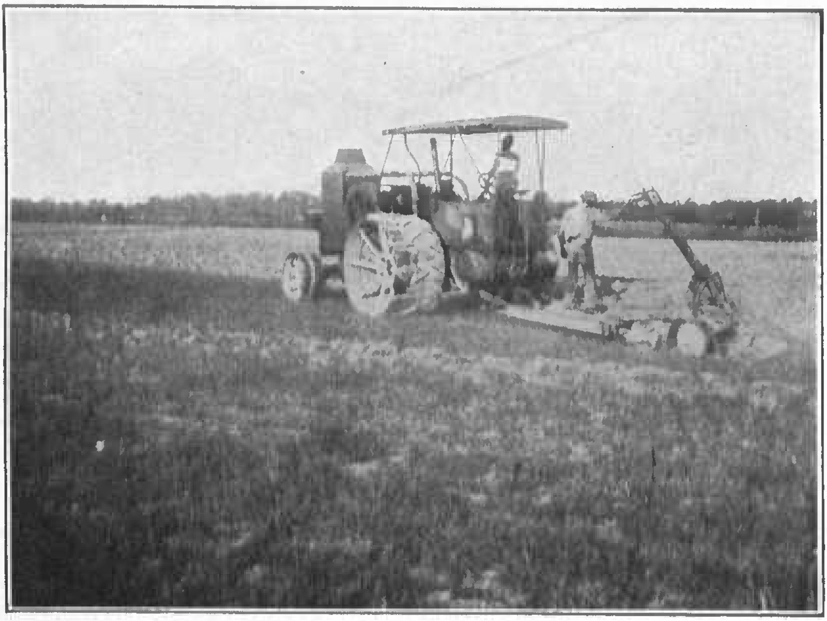

FIG. 6.—Plowing a rice field with a tractor, a common practice.

Spring-plowed land should be disked and harrowed immediately after plowing, because the soil dries out very rapidly under the action of the winds which usually prevail at this season, and if allowed to dry out a satisfactory seed bed can not be obtained. Under normal weather conditions, the heavy soils when spring plowed will require more disking and harrowing than if plowed in the winter. The use of the float also will be required several times. The lighter soils will need less work.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches. A seed bed of this character retains moisture and increases the chances of good germination with-

out irrigation. It also promotes such a vigorous growth of the young plants that submergence may not be required for 30 days.

PREPARATION OF THE SEED.

All seed rice should be graded and cleaned before it is sown. The fanning mill may be used for this purpose. Ungraded seed is likely

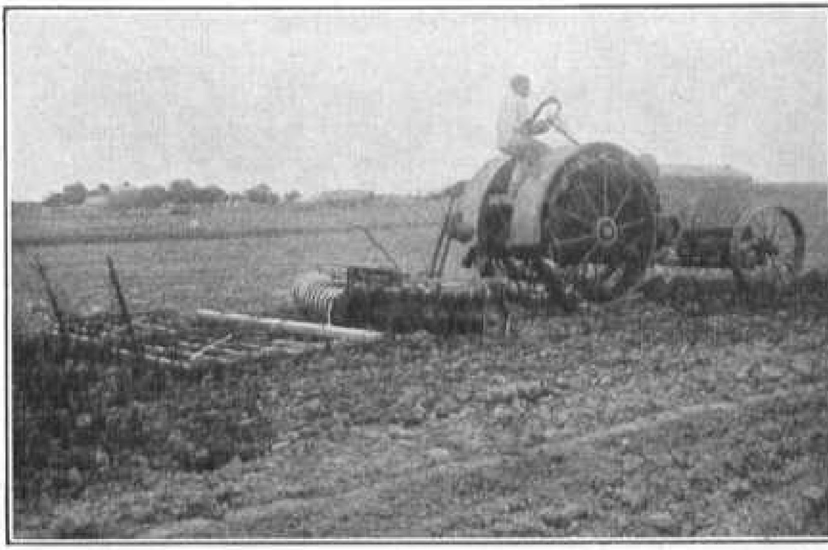

FIG. 7.—Preparing a seed bed for rice.

to produce a poor stand, and the use of uncleaned seed is one way by which weeds may be increased or introduced into a field. Although rice without hulls may germinate under favorable conditions, the grade of seed rice containing it should be considered inferior for seeding purposes. It is more easily damaged by unfavorable weather following seeding than the perfect seed which has the husk or hull attached. The use of seed containing rice without hulls results always in a thin stand or a stand with many weak plants.

FIG. 8.—A float or drag that is very useful in breaking clods and leveling a rice field before disking.

Seed rice should always be tested for germination, as it may have been exposed to weather conditions at harvest time that may affect its germinating power. For a germination test, several lots of 100 seeds each should be taken from a sample of the seed to be sown. Each

lot should be placed separately between blotting papers or canton flannel and kept moist at the temperature of a living room (70° F.) for at least a week. The number of seeds that have strong sprouts should then be counted. The seed that shows low vitality should not be sown, or, if used, the rate of seeding should be higher than that commonly recommended for the variety.

METHOD OF SEEDING.

Rice is usually sown with a 16-hole grain drill (fig. 9), although an end-gate broadcast seeder often is used. Of the two methods of seeding, drilling is preferred. It requires less seed and secures an even distribution at a more uniform depth, resulting in a better stand than usually is obtained by broadcasting. However, the latter has

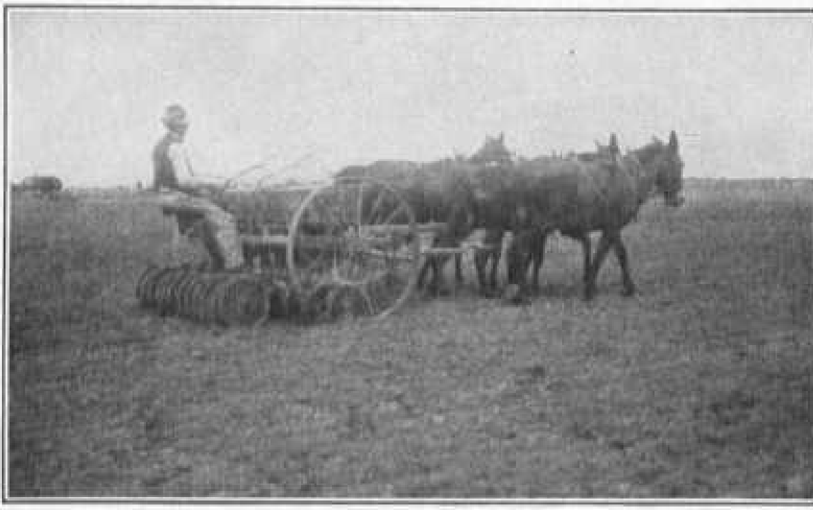

FIG. 9.—Drilling rice on a well-prepared seed bed.

advantages. If the soil dries out rapidly when wet weather occurs after the seed has been broadcasted, the stand is likely to be better than if the seed had been drilled, because on account of the shallow seeding the young plants have less difficulty in emerging. Considering all the conditions under which the crop may be sown, seeding with a drill is recommended. The disk drill is ordinarily used, but the shoe drill may give just as good results.

TIME OF SEEDING.

On the prairies the greater part of the rice crop is sown from April 1 to May 15. Under normal weather conditions the Honduras variety when sown during the first week in May matures during the first week in September. The other commercial varieties that are grown in this region when sown at the same time mature on an average from 14 to 23 days later.

Rice sown during the first week in May germinates within 9 to 12 days, but when sown in early April it may not germinate for 14 to 20 days. Seeding at the earlier date is not safe, because of the low temperatures prevailing at this season. Cold rains also are quite frequent, and when they occur the crop is often so badly affected by the rotting of the seed that reseeding is necessary. If sown in the third week of May rice germinates within seven days. Seeding as late as June 1 may be an advantage on weedy land when the land is plowed in the winter and cultivated repeatedly in the spring until the crop is sown. Rice can not be sown with safety as late in Arkansas as on the Gulf coast because the growing season is much shorter. May 1 is approximately the best date for sowing rice on the prairies.

RATE OF SEEDING.

In experiments at the Crowley Rice Station in Louisiana the largest yields and best quality of the Honduras variety were obtained by drilling 80 pounds of seed to the acre. The medium-grain and short-grain varieties may be sown at the rate of 65 to 75 pounds per acre. Less seed may be used when the crop is sown in late May if the seed bed is well prepared, as better germination is obtained at this time than at an earlier date. The quantity of seed that should be sown depends upon the method of seeding, the variety of rice, the character of the seed bed, the fertility of the soil, and the vitality of the seed. If sown broadcast on wet land and on a poorly prepared seed bed all varieties should be sown in excess of the rate recommended. Seed of low vitality should not be sown. If it must be used, the rate of seeding should be greatly increased. Seeding at too low a rate is likely to permit excessive tillering, which will result in irregular ripening and reduced yields.

DEPTH OF SEEDING.

The depth to which seed should be sown depends upon the condition of the seed bed. It should not exceed 2 inches. In attempting to cover seed on cloddy land to the depth of 2 inches an uneven depth is obtained, and a poor stand results. A less depth is desirable on a seed bed with a good moisture content. Shallow seeding, however, is not safe if water is applied to obtain germination. Deep seeding on a seed bed in good tilth may result in poor germination if heavy rains follow immediately after the seeding. Such rains may cause the soil to run together and become so compact that the seedlings can not emerge, resulting in a total loss or a poor stand. The damage may not be so great if the rains occur just before germination and if the soil does not dry out too rapidly.

FERTILIZERS.

Among the rice farmers in the section covered by this bulletin who use fertilizers, it is not the practice to apply fertilizers containing the three important elements of plant food—nitrogen, phosphorus, and potash. The fertilizers that are commonly used contain from 10 to 12 per cent of phosphoric acid and 2 to 4 per cent of potash. They are applied at the time of seeding at acre rates varying from 150 to 200 pounds of acid phosphate and from 30 to 50 pounds of muriate or sulphate of potash. The rice soils of the prairies are, as a rule, deficient in phosphorus, but in most of them there is enough potash. When absent, these plant foods can be restored to the soil in the form of commercial fertilizers. Even when they are present they are not always available, though a good supply of decaying vegetable matter in the soil tends to make them so. It is important, therefore, that the soil should be supplied with humus in order to get the full use of the plant food that may be stored in it.

If conditions are made favorable for nitrification, or the formation of nitrates, considerable nitrogen may also be furnished by this vegetable matter. Plowed-under stubble on well-drained land will greatly increase the amount of available nitrogen and may supply what is needed. A large part of the nitrogen and potash consumed by the rice plant is stored in the straw and is saved if the straw is plowed under. The burning of straw piles and stubble, therefore, is wasteful, so far as nitrogen is concerned. The potash is not completely lost, however, if the ashes of the burned straw are returned to the soil.

Most cultivated plants obtain their supply of nitrogen in the form of nitrates. These are made from vegetable matter through various processes of decay and oxidation. This requires free circulation of air in the soil. In the absence of the free air, these processes cease altogether or proceed at a very slow rate. During the greater part of the growing season rice is grown on submerged soil and under conditions which are unfavorable for the formation of nitrates. It is generally believed, however, that whenever sufficient organic matter is present, enough ammonia is formed to supply the nitrogen needs of the rice plant. In other words, rice may obtain its nitrogen in the form of ammonia. Ammonium sulphate and organic nitrogenous fertilizers are good sources of nitrogen for rice. The yield of rice has been greatly increased by the application of ammonium sulphate when supplied at the rate of 70 pounds per acre.

Nitrogenous fertilizers should be used with great care, for they produce a heavy growth of stem and leaves. Too heavy an application of such fertilizers is likely to result in lodging. To maintain the supply of nitrogen a leguminous crop should be grown in rotation with rice.

Lime may be applied with benefit to acid soils, but since rice can endure greater acidity than other plants the use of it may not always be an advantage. Excessive liming may reduce yields and affect the availability of phosphoric acid. For these reasons lime should be used in small quantities until the effect of it upon the soil and crop is determined. It may be used in the form of ground limestone, marl, or quicklime, but, of course, quicklime should be slaked before it is applied. Lime should be spread broadcast and harrowed in.

FIG. 10.—A field of rice. The land is covered with 5 inches of water. The levee in the center of the picture should have been made broader and lower and seeded to rice.

TIME TO APPLY IRRIGATION WATER.

The irrigation water usually is first applied when the young plants have reached a height of 6 to 8 inches. The subfields at this time are submerged to a depth of 1 to 2 inches. This depth of water is increased slowly until the maximum depth of 5 inches is obtained (fig. 10). By this time the plants should have reached a height of at least 2 feet. Throughout the growing season the maximum depth is maintained, fresh water being supplied when needed to equal the losses from seepage, evaporation, and transpiration. Irrigation is seldom used to germinate the seed except when the crop is sown at an early date.

When irrigation is required for germination, great care must be used in applying the water, for if water is left on the land too long

at this season of the year it is likely to cause the seed to rot. Before the plants come up, water should not be allowed to remain on the land longer than 48 hours after each irrigation. Under these conditions, the soil should never be allowed to bake before the plants have come up.

The amount of water required to make a good crop of rice will depend largely upon how well the outside levees have been constructed and what quantity of water is allowed to flow through the field. To conserve water, the levees should be made as seepage proof as possible. Poorly constructed outside levees are responsible for the loss of much water. The loss is further increased by allowing too much water to flow through the fields in an effort to keep the water fresh. Under general field conditions 28 acre-inches of irrigation water are required to produce a good crop of rice. This is in addition to the normal rainfall of 20 inches in the irrigation period.

DRAINAGE.

The irrigation water should be removed promptly from the rice field when the crop is ready to be harvested. To do this effectively, ample provision should be made for draining the field at harvest time. This will require a number of ditches of sufficient depth and width to drain the soil thoroughly as well as to remove the surface water. They must be kept free from all kinds of obstructions, especially weeds, which grow luxuriantly in them, or their efficiency will soon become greatly impaired.

The number and location of these ditches will depend upon the surface features of the land under cultivation. The surplus water should be carried away quickly. This can be done by connecting the field outlets with watercourses or artificial channels of sufficient capacity. The latter is an engineering problem requiring community cooperation and is being solved in many localities by the creation of drainage districts.

On fields that drain slowly there is always a delay in harvesting the crop, which invariably results in the loss of grain from shattering. This lack of drainage or poor drainage facilities will add also to the cost of production in the additional time and labor required to cut and move the crop from a boggy field. During the winter, all drainage outlets should be kept open, so that surplus water can not remain on the land. Such attention will prevent water-logging and serve to aerate the soil. The importance of having control of these conditions is strongly emphasized, for without this control maximum yields can not be obtained.

HARVESTING THE CROP.

Rice is harvested with a twine binder (fig. 11), with the exception of a comparatively small acreage along the Mississippi River, where the crop is cut with a hand hook. Rice should not be left standing until fully ripe, but should be cut promptly when the kernels in the lower part of the heads are not entirely hardened. This stage of maturity is indicated by the position of the heads, which are well turned down. If cut earlier the quality of the rice will be greatly affected by a large percentage of imperfectly formed kernels. If cut later there will be a loss of grain from shattering.

SHOCKING.

The harvested grain should be shocked in such a manner as to protect it from sun and rain. Too long an exposure to the sun is

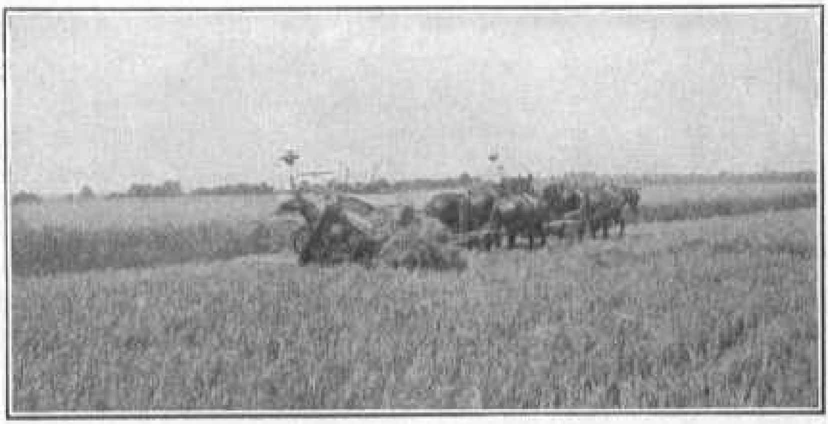

FIG. 11.—Cutting rice with a twine binder. Before harvest the irrigation water is drained from the field.

likely to crack the grain, and too much dampness will affect the proper hardening of it. Shocking should be promptly and carefully done. In a large measure the value of the crop depends upon the thoroughness of this work. Rice that has been carelessly shocked can not produce the maximum yield of head rice when milled. It is this grade of milled rice that commands the highest price, and the miller makes his highest bid on the rough rice which in his opinion will produce the largest proportion of this grade.

The shocks (fig. 12) should be strongly built to withstand the wind and well capped. The first two bundles of a shock should have the butts firmly set into the stubble and sufficiently apart to be well braced when the heads are brought together. Place around these 8 to 10 bundles, so as to form a round shock, making provision at the same time for free circulation of the air. A large bundle should be selected to serve as a cap. Slip its band down to the heads and

put it in an upright position, with the heads down in contact with the heads of the bundles forming the shock. When it is in this position, open the bundle from the center by bending the straw at the band. Pull down the straw and spread it evenly to make a covering for the heads of the cap bundle and the underlying bundles. When the straw is wet or not entirely ripe, it is probably safer to make a smaller shock.

THRASHING.

Rice should not be thrashed (fig. 13) until the kernel is hard and the straw thoroughly dry. This requires at least two weeks in the shock when the weather is dry. If the weather is rainy this period may be considerably prolonged. The damage to grain in a well-

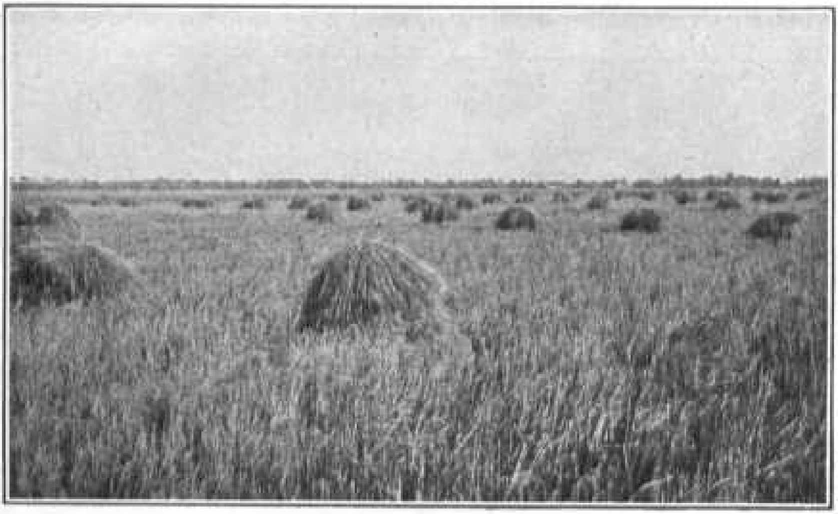

FIG. 12.—A field of shocked rice in Louisiana. These shocks have been strongly built and well capped, to protect the grain from rain and sun.

constructed shock exposed to heavy rains is negligible compared to the loss that may occur when thrashing is done too soon. The grain should not be thrashed too early in the day, even though it has been thoroughly cured in the shock. If thrashing is attempted while the straw is damp with dew there is likely to be poor separation and, of course, a loss of grain. There is danger, also, of further loss by heating if the grain is sacked and stored while damp. When thrashing is done under contract or where more than one variety is grown on a farm, special attention should be given to the cleaning of the separator. This is necessary to keep the varieties as pure as possible and to prevent the introduction of weeds from neighboring farms. Rough rice is greatly improved in grade by careful thrashing, and too much attention can not be given to the adjustment of the concaves in order to prevent hulling and cracking.

WEEDS.

The conditions under which rice is grown favor the rapid and rank growth of other plants that thrive in water and wet soil. These plants may become troublesome weeds if not eradicated when they first appear in the field. If weeds are allowed to grow they may reproduce so rapidly that a large part of the field may soon be occupied by them and thus cause heavy loss by reducing the rice yield. The loss is further increased by the presence of their seeds in the rough rice, which greatly affects the value of the crop. A weedy crop never has a high market value.

On account of their general hardiness and the large number of seeds which many of them are capable of producing, weeds are not easily controlled. Since the control and eradication of weeds increase the cost of production, it is very important that every method

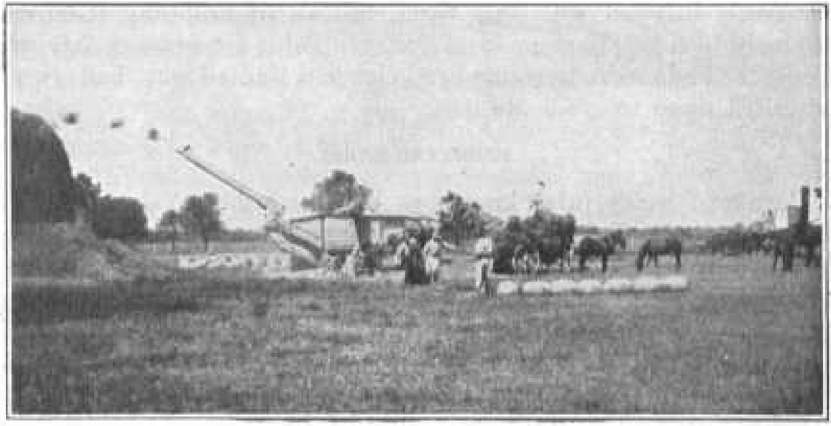

FIG. 13.—Thrashing rice in Louisiana.

be used to prevent them from getting into the field. The danger of weed introduction may be greatly reduced by using only seed rice that has been thoroughly cleaned. To prevent the distribution of weeds by irrigation water and wind, all ditches and levees should be kept clean. If weeds are allowed to grow in these places they will soon be scattered to all parts of the field. The community thrashing outfit often is responsible for the distribution of weeds and should always be thoroughly cleaned before using.

RED RICE.

The worst weed of the rice fields of the United States is red rice. It is well distributed throughout the rice-producing countries of the world. The seed coat of the kernel of this rice is red, a characteristic which may serve to distinguish it from the white rices. It is introduced only through the use of seed containing red rice. Wherever

this happens it soon takes possession of the field unless active measures are taken to eradicate it. In discussing seed rice from the standpoint of red rice only, the importance of pure seed can not be overestimated. After heading, red rice can be readily distinguished from our commercial varieties by its loose, open, slightly drooping head with comparatively few grains on the branches.

A slight infestation of a small acreage may be easily controlled during the first year by pulling up the individual plants and removing them from the field. If this is not done the quantity of red rice the second year will be greatly increased, for the seed of this rice shatters very badly. Of course, some of it will be harvested and thrashed with the main crop, but the quantity will be proportionately small, though large enough to affect the grade. The presence of red rice always lowers the value of the crop.

It is a common practice to pasture every second year fields that are badly infested with this weed, instead of cropping them successively to rice. In some localities such fields are summer fallowed. These methods serve to control red rice in a limited way, but can not be relied upon to eradicate it.

BARNYARD GRASS.

Barnyard grass (also known as barnyard millet) is a common rice-field weed. It has been known and kept under control in South Carolina by hand cultivation for more than a century. In the prairie-rice districts this weed has caused no heavy losses, but it is spreading so rapidly in some localities that an effort should be made to control and eradicate it. It is a coarse, erect or spreading annual, varying in height from 12 to 48 inches. It is widely distributed in all cultivated regions and grows luxuriantly in fields that are irrigated. It is not safe to allow a single plant to go to seed, as it produces a large number of seeds under the conditions that prevail in a rice field. This weed probably has been more widely distributed through the use of the seed rice containing its seed than by any other means. If it is allowed to grow upon the banks of irrigation ditches the water from them will carry its seeds over entire fields.

Seed rice containing the seed of this grass should not be used. As soon as this weed appears in a field it should be destroyed; at any rate before it produces seed. On account of their large root systems it is not practicable to pull up the plants. They should be cut below the surface of the ground to prevent new growth. Plants which have been cut at the surface have been known to grow and produce seed several times during a season. As soon as they have been cut the plants should be removed from the field, for if allowed to remain in moist or wet places, they will continue to grow.

This weed may be controlled by summer fallowing if the soil is so tilled as to make favorable conditions for the germination of the seeds that are in it. Shortly after germination, before the plants have had time to flower, they should be destroyed by shallow cultivation. Frequent shallow cultivations followed by irrigation to insure good germination of the remaining seed should result in complete eradication.

OTHER WEEDS.

No list of rice-field weeds would be complete that did not contain the large indigo, curly indigo, bull-grass, alligator head, Mexican weed, and many species of sedges. Of these the Mexican weed is the most difficult to control and eradicate. The crop losses due to these weeds may be greatly reduced by using a cultivated crop in rotation with rice where such a crop can be profitably grown.

DISEASES.

In this country the rice plant is subject to attack by several diseases, only a few of which are of economic importance. One of these is apparently of nonparasitic origin, although several organisms have been found associated with it.

Blast, blight, and rotten-neck are common names for a fungous disease caused by *Piricularia oryzae.* This fungus attacks the swollen base of the leaf sheath and the base of the upper leaf blade, and also is especially severe on the stem at the point where the head is attached, often called the neck. The general effects of the disease are seen in the paling and drying of the leaf and stem and in the poor condition of the head. When the neck is affected, the kernels are usually poorly filled. If the attack occurs at this point after the kernels have developed, the stem usually breaks, resulting in the loss of the head and, of course, in reduced yields. The disease is occasionally very destructive to the young plants, causing the leaves to dry and shrivel. No preventive and remedial measures can be recommended until more is known about the life history of the fungus. As its greatest damage is done late in the season, the use of early-maturing varieties may lessen the losses. Varieties may be developed that will satisfactorily resist the disease.

The green smut (*Ustilaginoidea virens*) and the black smut (*Tilletia horrida*) occur so seldom in the United States that at present they are not of economic importance. Under certain favorable conditions they might become serious diseases.

The general effect of the disease commonly referred to as "straighthead" is seen in the erect and green heads, which seldom set any seed. All efforts to trace its origin to parasitic fungi or bacteria have failed. There is evidence that straight-head is caused by unbalanced soil conditions, connected in some way with soil prepara-

tion and irrigation. The plant, and particularly the head, remains green much longer than normal. No specific recommendation for its control can be made.

INSECTS.[1]

Among injurious insects may be mentioned several species which attack the stem and roots and developing kernel of the rice plant.

The developing rice kernel is often punctured by sucking insects, the most common one being the stinkbug (*Oebalus pugnax*), which also feeds on many grasses. When the kernel is punctured while in the very early milk stage it shrivels so badly that it becomes valueless. If punctured later its milling quality may be greatly affected, and if it should escape breaking in the milling processes its value as a finished product is lowered considerably because of the discoloration made by the growth of saprophytic fungi and bacteria within the puncture. This insect is not a serious pest until the individuals become numerous. As this does not occur until late in the season, late-maturing rices are more exposed to attack.

The stem of the rice plant is sometimes attacked by the larva of a moth (*Chilo plejadellus*). After boring into the stem the larva feeds upon its interior surface. This weakens the straw, and when the head emerges, after the attack, it loses its green color, becomes white, does not flower, and consequently does not set seed. The damage done by this insect is never great, and the infestation is usually local even in a small field of rice. As a general rule the insect attacks only plants where the growth is thick. Rices with large stems are more subject to injury than those with small ones.

The rice water-weevil[2] (*Lissorhoptrus simplex*), which in its larval stage is known by rice farmers as the "rice root-maggot," is the most injurious insect enemy of growing rice. It is known to damage the rice crop annually, but the extent to which it alone is responsible for low yields is not easily estimated. The loss, however, is large enough to make it worth while to use means for its control.

As soon as the irrigation water is applied to the rice fields, the adult weevil, which is approximately one-eighth of an inch long, appears and begins to feed on the leaves of the young rice plants. The injury done at this time is slight compared with the work of the insect in its larval stage upon the roots of the plant. The larvæ feed entirely upon the roots. It is the severe pruning that they give the roots which affects production. The plant is seldom killed, but its growth may be seriously stunted by the loss of many of its roots. The destroyed roots are gradually replaced by new ones. If the at-

[1] For more detailed information in regard to rice insects, see Webb, J. L., How insects affect the rice plant. U. S. Dept. Agr. Farmers' Bulletin. In press.

[2] Tucker, E. S. The rice water-weevil and methods for its control. U. S. Dept. Agr., Bur. Ent. Circ. 152, 20 p., 2 fig. 1912.

tack is not prolonged the injured plant revives and makes a very good growth, though it usually is late in heading. The bad effects of the larval attacks are seen in the unequal growth of the plants in the field. This causes the crop to ripen unevenly and delays harvest, which increases the risk of loss by shattering.

The most practical method for controlling this insect is to drain the fields within three weeks after the application of the irrigation water, while the larvæ are still young and before they have weakened the plants too much. Drainage at this time, if the fields are kept dry for at least two weeks, will destroy the larvæ in large numbers. A longer period of dry growth, especially if no rains occur, may injure the rice, and a shorter period is not likely to have any effect on the insect.

RICE PRODUCTS.

Rice leaves the thrasher with the hull or husk attached. It is called rough rice and in this condition is sold to the miller. In the mills it is prepared for the market. After the removal of the hull and seed coats, or skin, the kernels are polished. This process improves the commercial value of the rice but decreases its food value.

After the rough rice has been cleaned, to remove all kinds of trash, it is conveyed to the milling stones, between which the hulls are removed. From these stones it passes over horizontal screens, where the hulls and the whole and broken kernels are mechanically separated. The unbroken kernels are now conveyed to a set of machines known as hullers, in which the outer skin and much of the gluten layer of the grain, together with the germ, are removed by friction. After leaving the hullers the rice is screened in order to free it from the bran. It is again subjected to another scouring in a second set of hullers or in a pearling cone. It is now ready to be polished—a process which gives the kernels the pearly luster that is demanded by the general trade. In the polishing process more of the gluten layer and many layers of starch cells are rubbed off. This product is called rice polish. After the polishing the rice is screened. If it is to be coated with glucose and talc, as is generally done, it is conveyed to a revolving cylinder where the coating material is applied. The different grades of cleaned or milled rice are afterwards separated.

The unbroken kernels of milled or cleaned rice are known as head rice. This kind of rice always commands the highest price and is sold under several grades, which vary in the different markets but are separated largely upon the brilliancy of the polish and the color and size of the kernels. The broken kernels may be sold as ordinary or broken rice, screenings, or brewers' rice. The last grade is composed of very fine particles of the kernels.

The principal feeds that are obtained from rice are bran, meal, and polish. The bran is composed of the seed coat and the embryo with varying quantities of hulls. Bran that contains no hulls, or comparatively none, is called meal. It is the most nutritious of the rice feeds and when fresh is very palatable to domestic animals. On account of its high percentage of fat it often becomes rancid if kept too long. In the polish the percentage of fat and protein is much lower than in meal, while the percentage of starch is much higher. Polish is used for feeding cattle and pigs.

SUMMARY.

Prairie rice constituted approximately 75 per cent of the 40,424,000 bushels of rice produced in the United States in 1918.

Clay soils that are not too deficient in organic matter are adapted to rice culture when they lie in level tracts and can be cheaply drained.

Rice requires an abundant and always available supply of fresh water.

Poor drainage or the lack of drainage results in reduced yields and in a poor grade of rice.

The field levees should be low, broad, and permanent and constructed on contour lines at distances which will hold the water at an average depth of 5 inches. They should be seeded to rice, which will prevent any waste of land and leave no uncultivated strips in the field for the growth of weeds.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches.

May 1 is approximately the best date for seeding rice on the prairies.

The harvested rice should be shocked promptly, to protect it from the sun as well as the rain.

The shocks should be strongly built to withstand the wind and should be well capped.

Rice should not be thrashed until it has been in the shock for at least two weeks.

The danger of introducing weeds may be greatly reduced by using only seed rice that has been thoroughly cleaned and produced on fields that are not infested.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920


UNITED STATES DEPARTMENT OF AGRICULTURE